5. Reference Method Comparison ~~Minimum Conformance~~ Tests

This chapter explains the methods used to test the modeling and input capabilities of Alternative Calculation Methods (ACMs) relative to the reference program~~, DOE 2.1E, and the custom budget procedure described in this manual~~. ~~The~~ ACM ~~must~~shall be able to accept all required inputs but it need not be capable of modeling all features as long as it automatically fails proposed designs with features beyond its accurate modeling capabilities. For example, a simplified calculation method modeling only single zone HVAC systems could be approved if it automatically fails proposed designs that enter multi-zone HVAC systems for the proposed design ~~by an appropriate margin~~. For ACMs with limited capabilities, the vendor ~~must~~shall inform ~~the~~ users that the ACM is not capable of modeling certain ~~capabilities~~ features~~, and for compliance purposes, the ACM automatically~~ shall ~~fails any proposed buildings~~ design that uses inputs exclusive to ~~with~~ said ~~capabilities~~. While most of the tests are performed in three climate zones, some of the tests use other climate zones ~~are used for some of the tests~~.

There are a total of 76 specified tests.

All the runs described in this chapter ~~must~~shall be performed with the ACM, and run results ~~must~~shall be summarized on the forms contained in Appendix NA.

5.1 Overview

ACMs calculate six components of annual building source energy use:

1. Lights
2. Space cooling
3. Space heating
3. Indoor fans
4. Receptacles
5. Service water heating

To test the minimum ACM capabilities ~~for modeling annual source energy~~, it is necessary to perform a series of computer runs. Each computer run represents a systematic variation of one or more features that affects ~~total source time dependent valuation (TDV) of~~ energy use. Some of the parametric runs are performed in several climate zones for more than one prototype building. Most, however, are designed for only one prototype in just one or two of the climate zones.

For an ACM to be approved, the criteria described in Section 5.1.4 ~~must~~shall be met. This criteria compares the energy use differences, calculated using the ACM, to the energy use differences calculated using the reference calculation method. The energy use difference or compliance margin for each of these is the difference between any simulated proposed building design TDV energy ~~budget~~ and the standard design's TDV energy ~~budget~~. ~~The standard design is the corresponding simulated building if the design had included the features required by the prescriptive standards.~~ For this comparison the same ~~proposed building~~proposed design and ~~its~~ corresponding standard ~~building~~ design ~~must~~shall be used for both the candidate ACM ~~as is used with~~ and the reference program. A candidate ACM shall ~~These criteria must be~~ meet ~~for~~ (all) ~~(each and every one)~~ of the tests described in this manual. ~~where the reference method uses DOE 2.1E inputs and files similar to those described in the example input files shown in the appendices and the tests described in this chapter to model the proposed and standard buildings.~~

The ACM vendor is responsible for running the tests for the candidate ~~ACM~~ACM and the reference method ~~that is being submitted for approval~~. The vendor shall provide documentation, ~~showing the~~ reasons and engineering justification for ~~any~~ all inputs~~,~~ to the ~~vendors program~~ACM and the reference method~~, that, upon review, appear to produce erroneous or misleading results~~. ~~If the vendor believes that the reference program results presented in this manual and its supplement do not reflect the proper procedures described in Chapters 2 and 3 of this manual and (where not otherwise specified herein) the nonresidential energy efficiency standards, the vendor may also submit runs and results for the reference program, DOE 2.1E as an alternative to the results published in this manual. The vendor must thoroughly justify and document the reasons for the differences in the reference program inputs and results from the inputs and results presented in this Manual and the Supplement. If the Commission accepts the vendor's justification, the ACM may be approved based on the vendor's results for some of the tests.~~

5.1.1 Base Case Prototype Buildings

The tests are performed with ~~Descriptions of~~ four ~~theoretical~~ prototype buildings~~,~~ ~~are~~ summarized in the following paragraphs. The letter designation is used as part of the label for each computer run.

A) This prototype is a ~~theoretical~~ one-story building measuring 30 ft by 75 ~~fee~~t and is 12 ~~fee~~t high. Glass exists in a continuous band around the entire building perimeter with ~~its bottom edge~~ the sill 2.5 feet above the floor. The building has a single thermal zone.

B) This prototype is a ~~theoretical~~ two-story building measuring 60 ft by 60 ~~feet~~ ft and is 24 ~~feet~~ ft high. Glass exists in a mostly continuous band around the entire building perimeter on each floor with ~~its bottom edge~~ the sill at 2.5 ~~feet~~ ft above the floor. Most tests using prototype B have no interior zones. ~~For all practical purposes the applicant may assume adiabatic, mass-less walls facing the interior zones.~~ The building has four thermal zones per floor that are 15 ~~feet~~ft deep. In most of the tests using this prototype the interior zones have been purposely removed to increase the sensitivity to envelope measures using separate orientations and wall types for each ~~HVAC~~ thermal zone. The prototype should have adiabatic, mass-less walls separating the perimeter zones from the unconditioned interior zones. These separate zones are more sensitive to the measures examined than an envelope- dominated single zone which can mask orientation and individual wall effects. The sensitivity to HVAC sizing methods is also increased when this prototype is envelope dominated.

   In some tests to measure internal energy use differences or economizer cycle sensitivity, the 30 ft by 30 ~~foot~~ft interior space becomes two conditioned zones (one on each floor) served by a separate package variable air volume system. In these cases there are five thermal zones per floor.

C) This prototype is a six-story building measuring 60 ft by 60 ~~feet~~ft by 66 ~~feet~~ft high. Glass exists in a mostly continuous band around the entire perimeter of the building on each floor with ~~its bottom edge~~ the sil 2.5 ~~feet~~ft above the floor. The building has a total of fifteen thermal zones: Five on the first floor, five on the middle floors and five on the top floor. A multiplier of four is used for the middle floors.

D) This prototype ~~is like~~ represents a tenant improvement space in that it has only two exterior walls with two demising "party" walls ~~with R-11 insulation between steel framing members~~. The "party" walls are each adjacent to an unconditioned space of the same dimensions as the conditioned space (viz. 20 ~~feet~~ft wide, 60 ~~feet~~ft deep and 12 ~~feet~~ft high). These party walls have nominal 2x4 steel stud framing with R-11 insulation between framing members and 0.5" sheetrock on either side [CONS = DEMISING]. The unconditioned space has three other exterior walls that use the IV11-A2 ~~W1A~~ wall-type construction. The roof/ceiling of the unconditioned spaces has R-11 insulation between 2x6 wood framing members [[IV3-A2]~~RF1B~~]. The D prototype building (both conditioned and unconditioned spaces) ~~is built~~ has a slab-on-grade floor. The unconditioned spaces are modeled using a slab without carpet or pad and with no slab edge insulation. For the conditioned space, the ~~nominally "west"~~ back wall is heavyweight concrete with no windows and a wood door and the ~~front "east"~~ front wall is a steel-framed wall with glazing. The space is 20 ~~feet~~ft wide and 60 ~~feet~~ft deep and has a height of 12 ~~feet~~ft. The glazing begins at ground level but varies in height from 4.8 to 6 ~~feet~~ft. Tests with this prototype use overhangs and skylights and rotate the whole building geometry.

The base case prototype buildings have the same geometry and ~~zonation~~ zoning in all climate zones~~, although prototype B may have ten (10) zones rather than eight (8) for some of the tests.~~ . Default building parameters for the proposed designs are indicated for each series. Parameters not described or defaulted in the series are those given in Appendix NF.

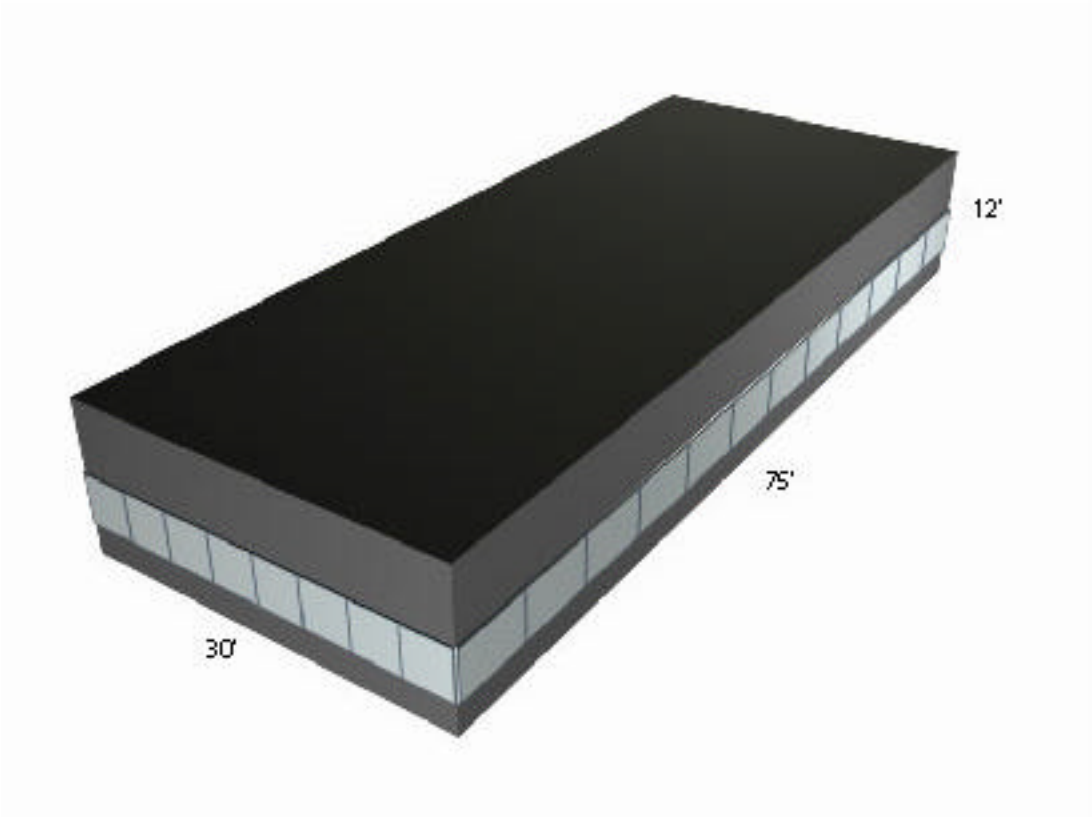


Figure N5-1 – Prototype A

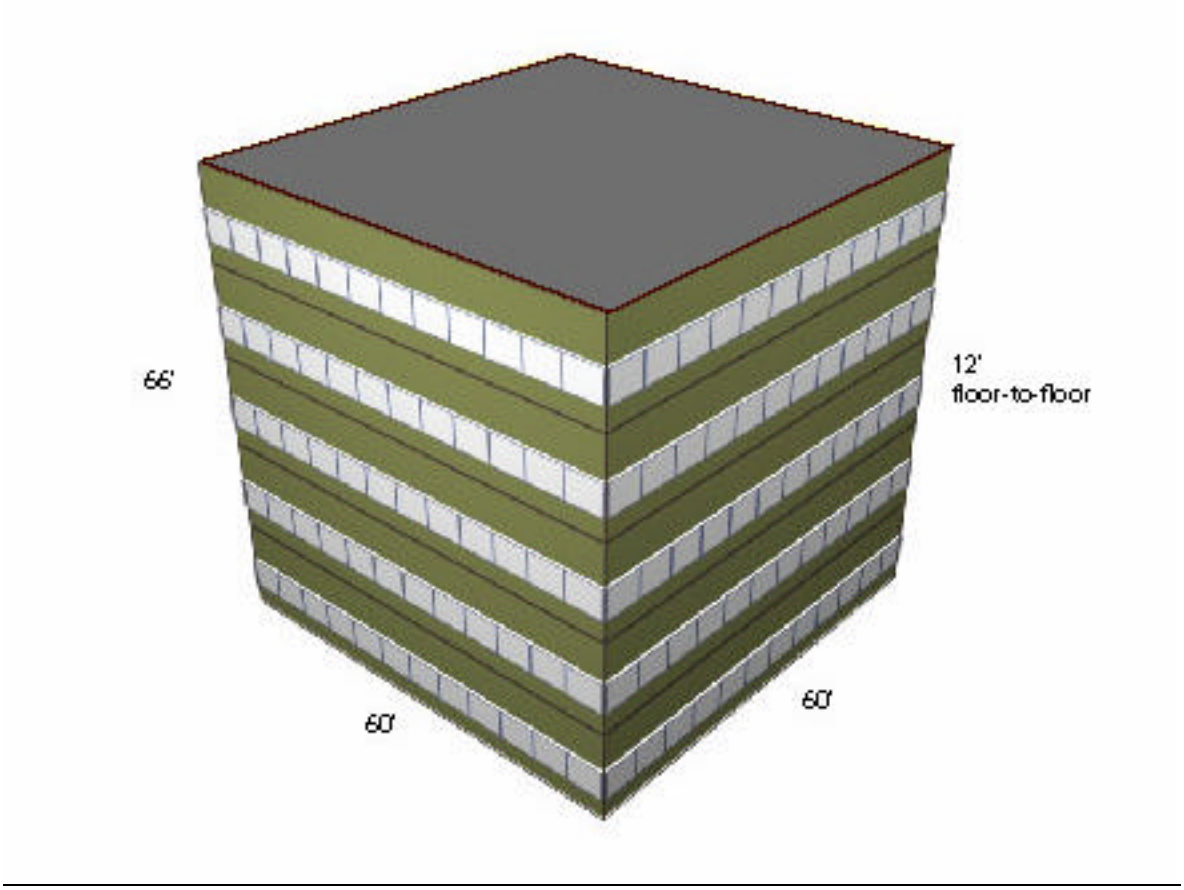


Figure N5-2 – Prototype B and C

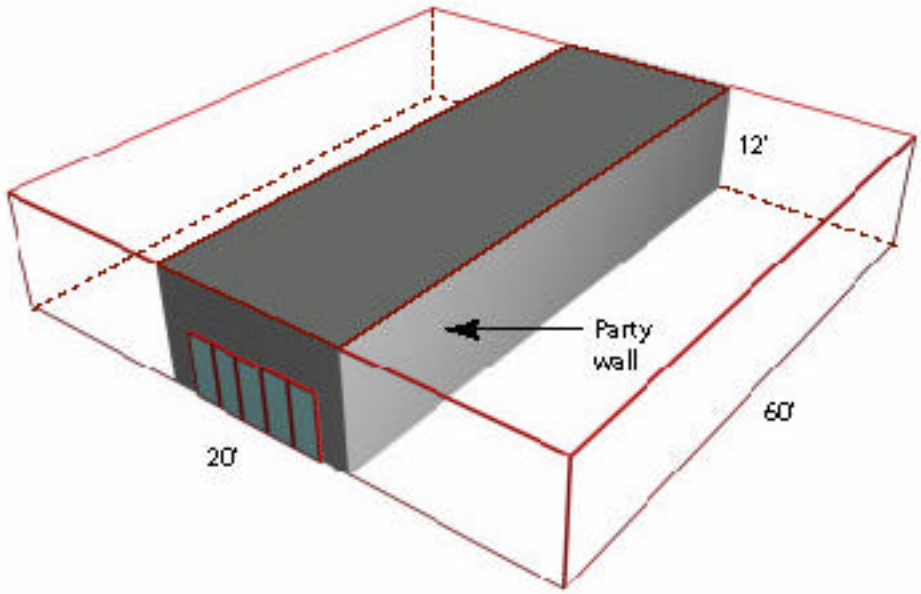


Figure N5-3 – Prototype D

5.1.2 Climate Zones

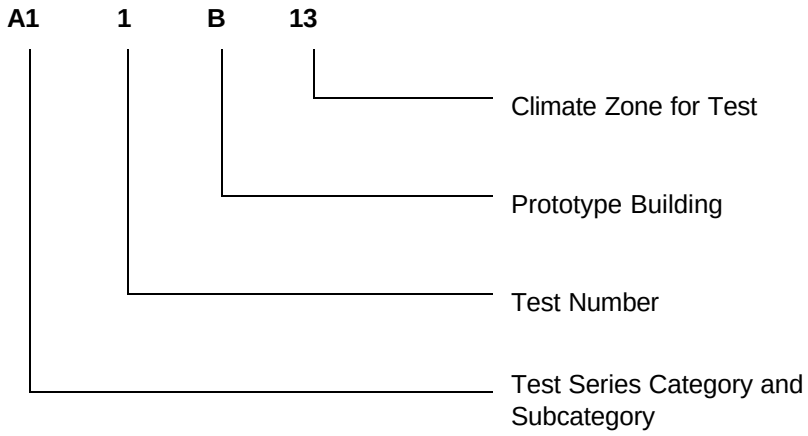
Eleven of the 16 climate zones ~~and a sampling of city locations within climate zones~~ are used in the tests ~~(Table 5-1)~~. These were chosen to represent distinctly different climate types.

Table N5-1 – Climate Zones Tested

Climate Zone	~~Weather Location~~Example Cities
1	Arcata, Eureka
3	Oakland, San Francisco
7	San Diego
9	Pomona, UCLA
10	Riverside
11	Red Bluff, Redding
12	Sacramento, Davis, ~~Crockett, Fairfield,~~ Roseville
13	Fresno, Visalia
14	China Lake
15	El Centro, Palm Springs
16	Mount Shasta, Tahoe City

5.1.3 Labeling Computer Runs

Each computer run used for the certification tests is given a precise designation to make it easier to keep track of the runs and to facilitate analysis. The following scheme is used:



~~The first three alphanumeric characters uniquely identify the test number. In this case A11 uniquely identifies the test case.~~

5.1.4 Test Criteria~~Comparison of Results~~

~~The~~ Software vendors shall perform a series of computer runs that systematically vary ~~model~~ the building ~~characteristics~~ prototypes described in Section 5.1.1. These tests consist of a series of matched pairs of computer runs. Each matched pair consists of a proposed design (prototype variation) and the standard design equivalent to the proposed design. The standard design equivalent is the proposed design automatically reconfigured by the ACM according to the rules presented in Chapter 2.

The variations or computer runs are described in Sections 5.2 and 5.3. The computer runs shall all be performed using the modeling assumptions described in this document. For each computer run, the results from the candidate ACM ~~must~~shall be within an acceptable range as defined in this section. ~~as modifications to each of~~

~~the base case buildings described in Section 5.1. The applicant shall provide results of runs for these building characteristics using consistent and equivalent input for the vendors ACM.~~ The results of these runs shall be compared to the results of a custom budget for the standard building developed by the same program. The applicant shall calculate the following.

$$DT_a = PT_a - ST_a$$

and the Commission has already determined:

$$DT_r = PT_r - ST_r$$

Where:

Subscript "a" represents the results of the applicants ACM and subscript "r" represents the results of the reference program, and

PT is the ~~total source~~ TDV energy for the proposed budget calculated for the building in kBtu/ft^2-yr,

ST is the ~~total source~~ TDV energy for the standard budget in kBtu/ft^2-yr.

For all tests, DT_a ~~must~~shall be greater than $0.85 \times DT_r$ - 1 kBtu/ft^2-yr when $DT_r \geq 0$ and DT_a ~~must~~shall be greater than $(1.15 \times DT_r - 1)$ when $DT_r < 0$ to be accepted for compliance use. If any of the tests fail to meet these criteria then the ACM will not accepted for compliance use.

For ~~In addition, for individual tests of~~ lighting and receptacle loads tests ~~(or water heating) measures~~, the ~~resultant lighting and receptacle source~~ TDV energy use of the candidate ACM~~s~~ shall be within 2.0% of ~~the resultant lighting source energy use of~~ the reference ~~program or the Commission shall not accept the applicants ACM~~method.

The reference method does not allow for undersized systems to be simulated for compliance purposes. **ACMs ~~must~~shall also model adequately sized HVAC systems~~, and c~~**Compliance runs that ~~indicate~~ result in undersized equipment or equipment that cannot meet the heating or cooling loads for a significant fraction of the simulated run shall not be approved for compliance purposes. **For ACMs ~~whose calculational engines~~ that report the hours that loads are not met or the hours outside of throttling range, reports ~~must~~shall indicate that these hours are less than 10% of the hours of a year for each and every test in order for an ACM to qualify for approval.**

The vender shall ~~results of these runs are~~ summarize the results ~~d in tabular form as a part of~~ on the forms provided in Appendix NA ~~for the vendor to enter the data from their ACM test results~~. As previously described, the vendor applicant may challenge the reference program results by providing alternative reference program runs and adequate documentation justifying different reference program results from those given in the Appendix NA.

5.2 General Requirements ~~Required Capabilities Tests~~

An ACM ~~must~~shall automatically perform a variety of functions including those described in Chapter 2.

- ~~It~~ The ACM ~~must~~shall accept a specified range of inputs for the proposed design, and ~~. It must~~ then use these inputs to describe the proposed building on the required output forms. The proposed building inputs are also used to create a standard design building based on the proposed building and the energy budget generation rules used to incorporate the prescriptive requirements into the proposed design. Certain building descriptors remain the same for both the proposed and standard design but others will change in ways that depend upon the design characteristics, the climate zone, and the prescriptive and mandatory requirements of the standards.
- ~~ACM assumptions for the DOE 2.1E computer program are given in brackets, e.g. [OH-A=0] or are described in information blocks of CAPITAL LETTERS.~~ The ~~energy budget generator~~ ACM ~~must~~shall automatically define the standard design; determine the proper capacity of the HVAC equipment for the standard design; adjust the HVAC capacity of the standard design in accordance with the reference method; and automatically run the standard design to establish the energy budget.

- The ACM shall performs the energy budget run in sequence with the compliance run with no user intervention or input beyond that of the proposed design. The results are reported in Part 2 of the Performance Certificate of Compliance Form (PERF-2) when the proposed building design complies.

At a minimum tThe applicant will shall perform the tests listed in this Manual to assure the proper response of that the ACMACM produces results in general agreement with the reference method. These tests verify the implementation of the custom budget procedure, program accuracy and performance relative to the reference program, and acceptable use of calculation inputs.

These tests consist of a series of matched pairs of computer runs. Each matched pair consists of a proposed design (prototype variation) and the standard design equivalent to the proposed design. The standard design equivalent is the proposed design automatically reconfigured by the ACM according to the rules presented in Chapter 2.

The vendor/applicant mustshall submit the completed forms from Appendix NA, ACM Application Test Results Summary and backup documentation for the results of the tests described herein. For buildings that DO NOT COMPLY, the vendor mustshall supply diagnositcdiagnostic output that indicates noncompliance and gives the TDV energy budget information needed to evaluate the test criteria, including the lighting and receptacle portions of the energy budgets for both proposed and standard design. For building designs that do comply, the vendor/applicant mustshall submit copies the Certificate of Compliance generated by the ACM. of Part 2 of the PERF-1 forms for all of the test cases.

Detailed information on the local and description of exterior partitions (walls, roof/ceiling, and floors) and the HVAC system and equipment information for each zone of each test is given in Appendix F.

For some of the tests, specific occupancy mixes are used in these tests and these are designated by the primary occupancy. The distribution of occupancy areas of these mixes are given in the table below. These mixes were selected to result in lighting energy densities nearly the same as those for the occupancy assumptions for spaces/areas without lighting plans.

Table N5-2 – Occupancy Mixes for Tests

Primary Occupancy	Suboccupancy Percentages			
Mix Type	*Primary*	*Office*	*Corridor/Support*	*Storage*
Office	87.5%	87.5%	12.5%	
Retail	85.0%	3.5%	3.5%	8.0%
Clinic	85.0%		15.0%	
Storage	72.0%	18.0%	10.0%	
Grocery	82.0%	4.0%	6.0%	8.0%
Theater	70.0%	16.0%	4.0%	Lobby 10.0%
Restaurant	Dining Area 75.0%	Kitchen 15.0%	5.0%	*Storage* 5.0%
Other	*Other*100.0% (Receptacle Load at 1.0 W/ft^2)			

5.2.1 Partial Compliance Tests - A1 Series (3 tests)

The partial compliance tests use the single zone version of the A building prototype with the same features used (except as noted) in test C11A10 in Section 5.2.4.1.

Test A11A09: Building prototype A - climate zone 09 - Pomona

Partial compliance - envelope only.

Test A12A09: Building prototype A - climate zone 09 - Pomona

Partial compliance - lighting only - Envelope is already existing as input. Proposed lighting plans specify lighting watts per square foot:

Subzone Space Occupancy	Percentage of Area	Proposed Lighting
Grocery Sales Area	82%	1.50
Grocery Storage (Commercial Storage)	8%	0.80
Support/Corridors	6%	0.80
Office	4%	1.80

Test A13A09: Building prototype A - climate zone 09 - Pomona

Partial compliance - envelope and mechanical only. No lighting plans submitted for grocery occupancy.

5.2.2 Exterior Opaque Envelope Tests

The exterior wall tests help to evaluate whether the applicant ACM inserts the correct wall assemblies into the standard design as a function of the proposed design including wall frame type, heat capacity, occupancy type and climate zone. These tests use the eight (8) zone B building prototype without interior zones to increase the tests sensitivities to envelope energy impacts.

The default characteristics for these tests are:

- Prototype building B (geometry, zones, and walls)
- Office occupancy with no lighting plans
- 3.5 inch concrete slab-on-grade floor [U-F CONS=SLABC]
- Wood-framed roof - framing materials and layers type ~~RF1C-~~IV2~~3~~-A5~~- wood framing fraction is 10%.~~.
- All wood-framed vertical walls [IV9-A2~~W2A~~ walls] have a 2~~1~~5% framing fraction, i.e., 7~~8~~5% of the wall is insulation.
- Package single zone system (gas furnace) without economizers or package variable air volume system with economizer cycle [Standard DOE 2.1E Economizer] and 75 degree Fahrenheit economizer limit temperature - [ECONO-LIMIT-T = 75.0]
- Window wall ratio = .10 for opaque envelope tests
- [WWR = 0.10]
- Glazing performance equal to prescriptive requirements
- Lighting wattage at 1.50 watts per square foot

Opaque Exterior Envelope - A2 Series (7 ~~(~~tests~~)~~)

These tests use the default B prototype building geometry and zone configuration. Run tests using wall assemblies ~~W2A~~IV9-A2, ~~W1A~~IV11-A2, ~~W4A~~IV13-D5+IV19~~14~~-A1, and ~~W3A~~IV13-B2+IV19~~14~~-F7 for north, east, south and west walls respectively and roof assembly IV3-A5~~RF1C-NR~~. The framing percentage used for wood frame walls, e.g.~~,~~ wall type ~~W2A~~IV9-A2, is 2~~1~~5% ~~[i.e. 15% of the wall is W2A-FRM and 85% is W2A-INS] and the framing percentage used for wood frame roof/ceilings is 10% [e.g. 90% is RF1C-NR and 10% is RF1C-NRF]~~. For Tests A21 and A25 use package single zone [PSZ] HVAC equipment in climate zones 13 and 03 respectively. For tests A22, A23, A24 use a package variable air volume [PVAV] system in climate zones 13, 06, and 16 respectively. Test again (A26 and A27) using wall assemblies ~~W2D~~IV9-A3, ~~W1D~~IV11-B4, ~~W4D~~IV13-D5+IV19~~14~~-F7, and ~~W3B~~IV13-B2+IV19~~14~~-D7 for north, east, south and west walls respectively and roof assembly ~~RF1D-NR~~IV3-H5. For test A26 use a package single zone [PSZ] HVAC system in climate zone 13 and for test A27 use a package variable air volume [PVAV] system in climate zone 16.

Table N5-32 – A2 Test Series (Summary)

Test Run	HVAC System	North Wall	East Wall	South Wall	West Wall	Roof
A21B13	PSZ	IV9-A2W2A	IV11-A2W1A	IV13-D5+IV1914-A1W4A	IV13-B2+IV1914-F7W3A	IV3-A5RF1C-NR
A22B13	PVAV	IV9-A2W2A	IV11-A2W1A	IV13-D5+IV1914-A1W4A	IV13-B2+IV1914-F7W3A	IV3-A5RF1C-NR
A23B06	PVAV	IV9-A2W2A	IV11-A2W1A	IV13-D5+IV1914-A1W4A	IV13-B2+IV1914-F7W3A	IV3-A5RF1C-NR
A24B16	PVAV	IV9-A2W2A	IV11-A2W1A	IV13-D5+IV1914-A1W4A	IV13-B2+IV1914-F7W3A	IV3-A5RF1C-NR
A25B03	PSZ	IV9-A2W2A	IV11-A2W1A	IV13-D5+IV1914-A1W4A	IV13-B2+IV1914-F7W3A	IV3-A5RF1C-NR
A26B13	PSZ	IV9-A3W2D	IV11-B4W1D	IV13-D5+IV1914-F7W4D	IV13-B2+IV1914-D7W3B	IV3-H5RF1D-NR
A27B16	PVAV	IV9-A3W2D	IV11-B4W1D	IV13-D5+IV1914-F7W4D	IV13-B2+IV1914-D7W3B	IV3-H5RF1D-NR

5.2.3 Envelope Glazing Tests

The envelope glazing tests are to check whether the ACM applicant inserts the correct vertical glazing types and areas into the standard design as a function of proposed design glazing orientation, area, occupancy and display perimeter length. As for the opaque envelope tests, the eight (8) zone B prototype building is used to enhance the sensitivity of the tests for envelope measures.

The prototypes for these tests have the following characteristics:

- Prototype building B, and if not otherwise specified.
- Retail store occupancy with no lighting plans, hence lighting is at 1.70 watts per square foot.
- Same wall and roof assemblies as for Section 5.2.2 base case file, namely, wall assemblies W2AIV9-A2, W1AIV11-A2, W4AIV13-D5+IV1914-A1, and W3AIV13-B2+IV1914-F7 for north, east, south and west walls respectively and roof assembly RF1C-NRIV3-A5.
- Window wall ratio default of 0.35 [WWR=0.35]
- 3.5 inch concrete slab-on-grade floor
- Package variable air volume system with economizer cycle and 75 degree Fahrenheit economizer limit temperature - [ECONO-LIMIT-T = 75.0]

Tests B31 and B32 use prototype building D to test skylight and display perimeter custom budget generation and to simultaneously test ACM overhang modeling.

The prototype has the following characteristics:

- Prototype building D
- Retail (85%) and storage (15%) occupancies hence lighting at 2.00 watts per square foot for the retail and 0.6 watts per square foot for the commercial storage portion at the back.
- 3.5 inch concrete slab-on-grade floor [U-F CONS=SLABC]
- At zero building azimuth the long axis of the building zones run due east to west.
- All "exterior" vertical walls of the two unconditioned zones are 2x4 steel-framed walls with framing 16" o.c. and R-11 insulation between framing members. These walls have stucco and plywood on the exterior and sheetrock on the interior [CONS = METALOCIV11-A2].

- The vertical walls between the conditioned zone and the two unconditioned zones are 2x4 steel-framed walls with framing 16" o.c. and R-11 insulation between framing members. These walls have sheetrock on both sides [CONS = INTWALL].
- The southern exterior vertical wall of the conditioned zone is a steel-framed ~~W1A~~IV11-A2 [METAL-WALL] wall and the northern wall is a massive [HEAVY-WALL] ~~W4A~~IV13-D5+IV19~~14~~-A1 wall.
- Wood framed roof - framing materials and layers type RF1C
- For the B31 and B32 test runs the window wall ratio is .50 for both exterior walls of the conditioned space [WWR = 0.50]. These windows start on the ground.
- The B31 and B32 test runs both include double pane skylights.
- Clear single pane glass for all glass with 9% aluminum framing with thermal break, SHGC=0.82, G-C=1.62, and VT=0.88.
- Package single zone system with economizer cycle and compressor lockout (non-integrated economizer [ECONO-LIMIT-T = 75]

Vary Window Wall Ratio - B1 Series (5 tests)

These tests exercise the automatic determination of standard design window wall ratios. These tests are performed using building B. The first three (B11, B12, and B13) are modeled in climate zone 13 and the last two in climate zones 06 and 16 respectively. Wall types ~~W1A~~IV11-A2, ~~W2A~~IV9-A2, ~~W3A~~IV13-B2+IV19~~14~~-F7, and ~~W4A~~IV13-D5+IV19~~14~~-A1 are used as in test series A2. All glazing performance characteristics shall be consistent with the prescriptive standards and no overhangs or side fins will be simulated. The glass will be a continuous band of uniform height around the entire building. Window wall ratios are set at 0.35, 0.40, and 0.45 respectively. The building with a WWR of 0.45 are also simulated in climate zones 06 and 16 for tests B14 and B15. When the window wall ratio is tested at 0.45 [WWR = 0.45] the proposed building is tested with clear low emissivity dual pane glass with 9% aluminum framing with thermal break, SHGC=0.58, G-C=0.68, and VT=0.72.

Tests: B11B13, B12B13, B13B13, B14B06, and B15B16.

Vary Glazing Types With An Overhang - B2 Series (4 tests)

These tests examine the ACM's sensitivity to the energy tradeoffs between extra glazing and overhangs. The first three tests are performed using building B in climate zone 12 with the building rotated 15 degrees to the east in azimuth. The last test is performed in climate zone 03. A retail occupancy is modeled. Overhangs, six ~~feet~~ft deep [OH-D=6], 60 ~~feet~~ft wide [OH-W=60], and 0.1 ~~foot~~ft above the top of the glass [OH-B=0.1] and no extension [OH-A=0] are modeled on the windows. However, no side fins or other building shading will be simulated. The glass will consist of two continuous bands with their bottom edges 2.5 ~~feet~~ft from the floor and a height equivalent to a window wall ratio of 0.42 [WWR =0.42] around the entire building. The first three runs will use the three different glass types indicated below for windows on all walls including the north wall. Clear low emissive dual pane glass [9% aluminum framing with thermal break, SHGC=0.58, G-C=0.68, and VT=0.72] will also be simulated in climate zone 03.

Tests: B21B12, B22B12, B23B12, and B24B03

Display Perimeter & Skylight Tests - B3 Series (2 tests)

These tests examine the ACM's sensitivity to variations in both display perimeter and skylights. These tests are performed using prototype D in climate zone 12. A 4 ~~foot~~ft deep, [OH-D=4], 20 ~~foot~~ft wide [OH-W=20] overhang, 2 ~~feet~~ft above the window [OH-B=2] with no extension [OH-A=0] will be modeled. The building will be rotated 165 degrees clockwise or to the east [BUILDING LOCATION AZ = 165] facing the glazed wall 15 degrees to the east of due South. No side fins or other building shading will be simulated. The glass will be a 6 ~~foot~~ft high panel of clear single pane glass [9% aluminum framing with thermal break, SHGC=0.82, G-C=1.62, and VT=0.88] on both exterior end walls with its bottom edge at floor height. The display perimeter option will be selected with a display perimeter of 40 ~~feet~~ft for the D prototype building. [WWR = 0.500 for six foot high glass.] Test B31 will have 5%

of the roof area in double pane transparent skylights [9% aluminum framing with thermal break, SHGC=0.44, G-C=1.02, and VT=0.80] and test B32 will have 10% of the roof area in double pane translucent skylights [9% aluminum framing with thermal break, SHGC=0.70, G-C=1.02, and VT=0.61].

Tests: B31D12 and B32D12

5.2.4 Occupancy Tests

The occupancy tests check to see if the ACM applicant inserts the correct schedules, envelope performance requirements, fixed values for internal loads and ventilation rates as a function of the occupancy type. Window wall ratio has been lowered to 0.20 for building prototype A and 0.30 in prototype B to increase the sensitivity of the tests to the choice of occupancy.

The prototypes for these tests all have the following characteristics:

- Prototype building A
- Specified occupancy mixes except lighting at 0.05 watts per square foot higher than allowed by Table N2-2 with lighting plans submitted.
- Wood framed roof - framing materials and layers type RF1B
- Suspended wood floor - framing materials and layers per Joint Appendix IV~~similar to nonresidential manual~~, floor type IV24~~22~~-A1~~FX.0.2X6.16 with 10% 2x6 framing and no insulation. Note that the interior air film is 0.61 and thus the overall U-factor is 0.260.~~
- Package single zone system with economizer cycle and 75 degree Fahrenheit limit temperature
- [ECONO-LIMIT-T = 75.0]
- Window wall ratio = 0.20
- Glazing meets prescriptive standards for CZ13

Tests will also be run for a mixed office, retail, restaurant, and heated-only warehouse occupancies for prototype building B and a second mixed occupancy test will be done using prototype C as a "prototype" high-rise hotel.

- Prototype buildings B (ten zone version)
- Modeled occupancy mixes except lighting at 0.02 watts per square foot lower than allowed by Table N2-2 with lighting plans submitted.
- 3.5 inch concrete slab-on-grade floor [U-F CONS=SLABC]
- Wood framed roof - framing materials and layers type RF1C
- Two (Interior Zones and Perimeter Zones) Packaged Variable Air Volume Systems with Electric Reheat and Economizer Cycle and 75 degree Fahrenheit economizer limit temperature for Prototype B. [ECONO-LIMIT-T = 75.0]
- Window wall ratio = 0.30 [WWR = 0.35]
- Glazing performance equal to prescriptive requirements

Prototype building C is described in detail below by the reference program input files. The mixed-occupancy high-rise hotel has a hotel lobby, office, and three retail zones on the first floor; hotel guest rooms on the middle floors; and three hotel function area zones, a kitchen, and dining zone on the top floor. In addition to the primary occupancy, each perimeter HVAC zone has 12% of its area as corridor, restroom, and support occupancy. The interior or core HVAC zones have 20% of their area as corridor, restroom, and support occupancy to account for elevators and electrical and mechanical chases.

- Prototype building C
- Lighting is set to the prescriptive requirement for each occupancy task/area per Table N2-2.

- Concrete spandrel panel walls [MAT = (CC22,~~W1B~~IV11-A3~~-R13~~,GP02)]
- Raised concrete floor

  for Floor1 ~~[MAT = (CEL-2.5,CC03,CP01)]~~IV25~~23~~-A4

  for Floor2 ~~[MAT = (CEL-2.5,CC05,CP01)]~~

  where

  [CEL-2.5 = MAT TH=.2083 COND=.0333 DENS=5 S-H=.32]
- Plywood deck, rigid insulation w/built-up roof exterior roof [MAT = (BR01,ISO-3.0,PW04)

  where

  ISO-3.0=MAT TH=.25 COND=.01417 DENS=1.5 S-H=.38]

  Interior Roof [MAT = (CC04,CP01)
- Variable air volume system with hot water reheat and economizer cycle and 75 degree Fahrenheit economizer limit temperature serving non-hotel room occupancies

  [ECONO-LIMIT-T = 75.0]
- Four pipe fan coil system serving all hotel rooms
- Window wall ratio = 0.35 [WWR = 0.35]
- Glazing performance equal to prescriptive requirements for climate zone 13. Double pane clear windows [9% aluminum framing with thermal break, SHGC=0.77, G-C=0.838, and VT=0.80] are used for north-facing glazing and non-north-facing guestroom glazing. Double pane bronze windows [9% aluminum framing with thermal break, SHGC=0.50, G-C=0.838, and VT=0.47] are used for non-north-facing glazing for all other occupancies.

Single Occupancy Tests - C1 Series (5 tests)

These tests will be performed using the Building A in climate zone 10 for the 5 occupancy mixes listed below. Sub-occupancy assumptions are given in Table N2-~~2~~-3 of this manual:

Grocery	82% Grocery Sales	8% Storage	6% Support	4% Office
Restaurant	65% Dining Area	30% Kitchen	5% Support	
Theater	70% Theater (Perf)	20% Lobby	5% Support	5% Office
Clinic	50% Medical-Clinic	25% Office	25% Support	
All "Other"	100% Other			

Tests: C11A10, C12A10, C13A10, C14A10, and C15A10

Mixed Occupancy Tests - C2 Series (2 tests)

a) This test will be performed using the ten zone version of Prototype Building B in climate zone 10 with the first story north and south zones retail, first story east and west zones heated-only warehouses and the first floor interior zone and all second story zones are office occupancies.

   Packaged single zone [PSZ] gas/electric HVAC systems are modeled in the heated-only warehouse zones in lieu of the packaged variable air volume [PVAV] system.

b) This test will be performed using the Prototype Building C in climate zone 16 with the first story having retail occupancies in all zones except for the west zone which is a hotel lobby and the south zone which is an office, four middle stories of hotel guest rooms with five zones per floor, and a top floor with hotel function

zones for the north, east, and west zones, a kitchen for the interior zone and dining occupancy in the south zone.

Tests: C21B10 and C22C16

5.2.5 Lighting Tests - D1 Series (4 tests)

The lighting tests check whether the ACM applicant inserts the correct lighting levels, per zone, into the standard design.

The prototype has the following characteristics:

- Prototype building D
- Retail area occupancy with lighting plans
- 3.5 inch concrete slab-on-grade floor [U-F CONS=SLABC]
- Wood framed roof - framing materials and layers type RF1C
- Window wall ratio of 0.30 [WWR = 0.30]
- Clear single pane glass for all glass with 9% aluminum framing with thermal break, SHGC=0.82, G-C=1.62, and VT=0.88.
- Package single zone system with economizer cycle and compressor lockout (non-integrated economizer [ECONO-LIMIT-T = 75]

These tests are performed using building D in climate zones 12 (Sacramento) and 07 (San Diego) with two different lighting levels, 1.50 watts per square foot and 1.70 watts per square foot.

Tests: D11D12, D12D12, D13D07, and D14D07

5.2.6 Ventilation Tests - E1 Series (6 tests)

The ventilation tests check whether the ACM applicant inserts the correct tailored ventilation rates, per zone, into the standard design. These tests are performed using Building D in climate zone 16 with three different combinations of tailored ventilation rates. Repeat these tests in climate zone 14.

The prototype has the following characteristics:

- One zone industrial and commercial storage occupancy with lighting plans showing 0.8 watts per square foot of lighting
- 3.5 inch slab on grade floor
- Wood framed roof - framing materials and layers [Roof Type RF1C]
- Window wall ratio of 0.10
- Clear double pane glazing on exterior walls with 9% aluminum framing with thermal break, SHGC=0.77, G-C=0.838, and VT=0.80.
- Package single zone system with no economizer

First, standard outside air per person [OA-CFM/PER] rates are used based on occupancy assumptions in Table N2-2~~1~~ or N2-3~~2~~. Next outside air per person [OA-CFM/PER] rates are increased by a factor of 1.5 as a tailored ventilation entry. Finally, outside air per person [OA-CFM/PER] rates are increased by a factor of three as a tailored ventilation entry.

Tests: E11D16, E12D16, E13D16, E14D14, E15D14, and E16D14

5.2.7 Process Loads Tests - E2 Series (6 tests)

The process loads tests check the energy budget effects of zonal process (tailored) equipment levels and microclimate sizing in a proposed building design. These tests are performed using prototype building B with conditioned interior zones in climate zone 16 (Tahoe City) with three different extra process loads of 0.50, 1.00, and 2.00 watts per square foot of process heat scheduled as equipment. Repeat these tests in climate zone 12 (Davis).

The prototype has the following characteristics:

- Prototype building B including 30'x30' interior zones
- Office occupancy
- 3.5 inch concrete slab-on-grade floor [U-F CONS=SLABC]
- Wood framed roof - framing materials and layers type ~~RF1C~~IV2~~3~~-A5
- Package variable air volume system with integrated economizer cycle and 75 degree Fahrenheit economizer limit temperature - [ECONO-LIMIT-T = 75.0]
- Window wall ~~eatio~~ ratio = 0.30 [WWR = 0.30]
- Single pane reflective glass with solar heat gain coefficient of 0.40 [9% aluminum framing with thermal break, G-C=1.62, and VT=0.22] everywhere.
- Lighting wattage at 1.20 watts per square foot

Tests: E21B16, E22B16, E23B16, E24B12, E25B12, and E26B12

5.2.8 HVAC System Tests - F1 Series (5 tests)

The HVAC system tests check the ACM's sensitivity to variations in HVAC system type and the selection of comparative systems for the standard design as a function of specific city location within climate zone, occupancy, square footage and proposed HVAC system type. Test F15A16 is a heated-only warehouse with electric resistance heating. The systems to be used for establishing custom budgets, are described in Chapter 2.

Tests 1 and 2 (F11A07 & F12A13):

- Prototype building A
- Medical office/clinic occupancy
- Window wall ratio of 40% [WWR = 0.40]
- Heat Pump System
- F11A07 modeled in climate zone 07 (San Diego)
- F12A13 modeled in climate zone 13 (Visalia)

Tests 3 and 4 (F13B12 & F14B12):

- Prototype building B - 8 zone version
- Retail occupancy
- Window wall ratio of 35% [WWR = 0.35]
- PVAV with electric reheat and no hot water coils or boilers
- F13B12 modeled in climate zone 12 (Sacramento)
- F14B12 modeled in climate zone 12 (Crockett)

Test 5: (F15A01)

- Prototype building A
- Heated only warehouse occupancy - gas-fired unit heater
- Modeled with clear, double pane, low emissivity glass, 9% aluminum framing with thermal break, SHGC=0.58, G-C=0.68, and VT=0.72.
- Window wall ratio of 35% [WWR = 0.35]
- Electric resistance heating - No cooling installed
- F15A01 modeled in climate zone 01 (Eureka)

Table N5-43 – F1 Test Series Summary

Test Run	HVAC System	Location	WWR	Occupancy
F11A07	Heat Pump	San Diego	0.40	Medical
F12A13	Heat Pump	Visalia	0.40	Medical
F13B12	PVAV with electric reheat	Sacramento	0.35	Retail
F14B12	PVAV with electric reheat	Crockett	0.35	Retail
F15A01	Electric resis. heating only	Eureka	0.35	Warehouse

5.2.9 System Sizing Tests - G1 Series (6 tests)

The system sizing tests check whether the ACM applicant calculates and simulates the correct capacities for both the proposed and standard design systems as a function of the input HVAC system capacities.

These tests are divided among undersized systems, oversized systems and combinations of oversized and undersized system components (e.g. oversized cooling and undersized zone reheating capacities). For the purposes of these tests OVERSIZED means 100 percent over estimated load and UNDERSIZED means 50 percent of the estimated load.

The system sizing tests will be performed in climate zones 3, 11, and 16. Tests 1,2,3 & 4 will be performed using building prototype A in climate zone 11 and tests 5 and 6 using the ten zone building prototype B in climate zones 03 and 16 respectively. Tests 5 and 6 will be performed using the ten HVAC zone version of prototype building B. Systems will be both undersized by 50% (tests 2 & 4) and oversized by 100% (tests 1 & 3.) Tests 5 and 6 have both undersized and oversized systems and components (boilers) serving different zones.

Tests 1 and 2 (G11A11 & G12A11):

- Prototype building A
- Medical office/clinic occupancy
- Window wall ratio of 40% [WWR = 0.40]
- Oversized (G11) and undersized (G12) PSZ - package gas/electric - system (gas furnace and DX cooling)
- Climate zone 11 (Red Bluff).
- No economizer

Tests 3 and 4 (G13A11 & G14A11):

- Prototype building A
- Medical office/clinic occupancy
- Window wall ratio of 40% [WWR = 0.40]
- Oversized (G13) and undersized (G14) heat pump system

- Climate zone 11 (Red Bluff).
- No economizer

Tests 5 and 6 (G15B03 & G16B16):

- Prototype building B - 10 zone version
- Office occupancy
- Window wall ratio of 35% [WWR = 0.35]
- Integrated economizers with 75 degree dry-bulb lockout
- For G15 - oversized boiler, undersized PVAV with electric reheat for exterior zones, oversized PVAV for interior zones
- For G15 climate zone 03 (San Francisco)
- For G16 - undersized boiler, oversized PVAV with electric reheat for exterior zones, undersized PVAV for interior zones
- For G16 - climate zone 16 (Tahoe City)

5.2.10 HVAC Distribution Efficiency Tests

ACM duct efficiency calculations shall be completed based on Appendix NG for the cases~~match the values~~ shown in Appendix NH.

5.3 Optional Capabilities Tests

ACMs may also model other optional capabilities or have optional compliance capabilities for additions and alterations. ~~In the last edition of this manual, tests for optional capabilities were left to be proposed by the vendor desiring to incorporate particular optional capabilities into their ACM. These tests were approved in conjunction with the approval of the ACM by the Commission. Most of the tests specified for optional calculation capabilities herein were originally proposed by the vendor of COMPLY24, Gabel-Dodd Associates. The tests for optional capabilities are based on the tests proposed by Gabel-Dodd Associates.~~

The first series of optional tests are special tests to test certain compliance options - partial compliance and modeling of an addition and an existing building with alterations. In addition to the test criteria for the energy results, compliance forms ~~must~~shall conform to the requirements for these special compliance options for the ACM to be approved.

The main body of optional capabilities tests deal with additional HVAC systems and plant capabilities that can be modeled by the DOE 2.1 (especially DOE 2.1E) computer program. These tests and the reference comparison method for these tests conform to the features and rules specified in Chapters 2 and 3 of this manual unless specifically noted otherwise.

5.3.1 OC Test Series - Compliance Options

Test OC1A09: Building prototype A - climate zone 09 - UCLA

Combined compliance for an altered existing building with a non-complying addition. Occupancy is an existing restaurant in a prototype A building. A new solarium is submitted as an addition to the restaurant. The solarium addition is 20 ~~feet~~ft deep by 30 ~~feet~~ft wide and is 12 ~~feet~~ft high adjacent to the wall of the existing building descends to 8 ~~feet~~ft at the outer glass wall of the addition. The addition has been added onto the eastern 30 ~~foot~~ft wide end of the A prototype building and that eastern wall and its glazing is removed with the construction of the addition. The vertical walls of the addition have 2.5 ~~foot~~ft knee walls with the rest of the walls consisting entirely of high performance glass:

- Knee walls - insulated spandrel panels

  SPANDREL-R10 assembly

- Sloped roof - insulated spandrel panels

  SPANDREL-R15 assembly

- Vertical glass walls

  GR4SC26 assembly [dual pane glass, 9% aluminum framing with thermal break, SHGC=0.26, G-C=0.2629, and VT=0.10]

- Sloped glazing in roof

  GR4SC18 assembly [dual pane glass, 9% aluminum framing with thermal break, SHGC=0.18, G-C=0.2629, and VT=0.08]

There is NO roof overhang extending beyond the addition's vertical walls. The original restaurant lighting of 2.00 watts per square foot has been altered to 1.60 watts per square foot to compensate for the extra glass in the solarium addition. The 30-~~foot~~ft wide eastern wall is removed to open the existing building to the solarium addition. The remainder of the A building prototype has exactly the same characteristics, including non-lighting occupancy assumptions, used in the proposed building for test C12A10 and is not altered for compliance. To be approved for the capability of partial compliance all ACM output and reporting requirements ~~MUST~~SHALL be met.

5.3.2 O1 Test Series - Fan Powered VAV Boxes

These tests use the ten zone version of the B building prototype with the same features used (except as noted) in test B11B13. All rules applicable to System #4 (Built-up VAV) described in Section 2.5 Required Systems and Plant Capabilities also apply to fan-powered VAV boxes or power induction units [PIU]. In particular, the rules used to determine a standard HVAC system are the rules for System #4.

Test O11B13: Building prototype B - climate zone 02 - Napa

Central VAV with hot water reheat. Each perimeter zone has a 600 cfm parallel fan powered VAV box. The reference method does not use the [ZONE-FAN-CFM] input, but does set [TERMINAL-TYPE = PARALLEL-PIU], [ZONE-FAN-KW is set greater than or equal to 0.00033], the [ZONE-FAN-T-SCH] is set 1 ^{o}F above heating setpoints, [MIN-CFM-RATIO = 0.3], and ACM input for the [ZONE-FAN-RATIO] or its equivalent is restricted to the range of 0.4 to 1.00. The ACM ~~must~~shall automatically determine or the ACM user ~~must~~shall enter an [INDUCED-AIR-ZONE] which is different than the zone served. For the reference program and method, the [INDUCED-AIR-ZONE] ~~must~~shall be the U-name (user name) of another zone.

Test O12B13: Building prototype B - climate zone 02 - Napa

Central VAV with hot water reheat. Each perimeter zone has a 600 cfm series fan powered VAV Box. The reference method does not use the [ZONE-FAN-CFM] input, but does set [TERMINAL-TYPE = SERIES-PIU], [ZONE-FAN-KW is set greater than or equal to 0.00033], the [ZONE-FAN-T-SCH] is set 1 ^{o}F above heating setpoints, [MIN-CFM-RATIO = 0.3], and ACM input for the [ZONE-FAN-RATIO] or its equivalent is restricted to the range of 0.4 to 1.00. The ACM ~~must~~shall automatically determine or the ACM user ~~must~~shall enter an [INDUCED-AIR-ZONE] which is different than the zone served. For the reference program and method, the [INDUCED-AIR-ZONE] ~~must~~shall be the U-name (user name) of another zone.

5.3.3 O2 Test Series - Supply/Return Fan Options

This series tests various fan options for central VAV system fans. These tests use the ten zone version of the B building prototype with the same features used (except as noted) in test B11B13. All runs have a central VAV HAVC system with a gas-fired boiler to supply hot water reheat.

Test O21B13: Building prototype B - climate zone 13 - Fresno

The supply fan uses an air foil fan with inlet vane control to control fan volume. The fan part-load curve is taken from the Commission's *DOE-2 Compliance Supplement*.

Test O22B13: Building prototype B - climate zone 13 - Fresno

The supply fan uses an air foil fan with discharge damper control to control fan volume. The fan part-load curve is taken from the Commission's *DOE-2 Compliance Supplement*.

Test O23B13: Building prototype B - climate zone 13 - Fresno

The supply fan uses an forward curve fan with inlet vane control to control fan volume. The fan part-load curve is taken from the Commission's *DOE-2 Compliance Supplement*.

Test O24B13: Building prototype B - climate zone 13 - Fresno

The supply fan uses a vane axial fan control to control fan volume. The fan part-load curve is taken from the Commission's *DOE-2 Compliance Supplement*.

5.3.4 O3 Test Series - Special Economizer Options

This series tests various economizer options. These tests use the A building prototype with the same features used (except as noted) in Test C11A10. All runs have a packaged single zone HVAC system with a gas-fired furnace and electric DX cooling. The building uses a grocery occupancy mix contained within a single (one thermostat) HVAC zone.

Proposed plans specify the sub-occupancies within the single HVAC zone with lighting watts per square foot:

Subzone Space Occupancy	Percentage of Area	Proposed Lighting
Grocery Sales Area	82%	1.50
Grocery Storage (Commercial Storage)	8%	0.80
Support/Corridors	6%	0.80
Office	4%	1.80

Test O31A12: Building prototype A - climate zone 12 - Fairfield

The HVAC system is equipped a fixed enthalpy integrated economizer control for more efficient cooling. The DOE 2.1E economizer function is used with [OA-CONTROL = TEMP], [ECONO-LIMIT-T = 75], [ENTHALPY-LIMIT = 25.0 Btu/lb], and [ECONO-LOCKOUT = YES].

Test O32A12: Building prototype A - climate zone 12 - Fairfield

The HVAC system is equipped a fixed enthalpy non-integrated economizer control for more efficient cooling. The DOE 2.1E economizer function is used with [ENTHALPY-LIMIT = 25.0 Btu/lb] and [ECONO-LOCKOUT = NO].

Test O33A12: Building prototype A - climate zone 12 - Fairfield

The HVAC system is equipped a differential enthalpy integrated economizer control for more efficient cooling. The DOE 2.1E economizer function is used with [OA-CONTROL = ENTHALPY].

5.3.5 O4 Test Series - Special HVAC Control Option

Test O41B13: Building prototype B - climate zone 13 - Fresno

This test exercises a warmest zone cooling coil control option. This test uses the ten (10) zone version of building prototype B with the same features used (except as noted) in test B11B13.

5.3.6 O6 Test Series - Additional Chiller Options

This series tests various chiller options. These tests use the ten (10) zone B building prototype with the same features used (except as noted) in test F14B13. All runs have a central HVAC system with one of the new chiller options and a gas-fired boiler and use hot water reheat.

Test O61B12: Building prototype B - climate zone 12 - Roseville

The chiller for this test is a single stage absorption chiller modeled with an EIR = 0.004 and an HIR = 1.6.

Test O62B12: Building prototype B - climate zone 12 - Roseville

The chiller for this test is a two stage absorption chiller modeled with an EIR = 0.004 and an HIR = 1.0.

Test O63B12: Building prototype B - climate zone 12 - Roseville

The chiller for this test is a gas-fired absorption chiller modeled with an EIR = 0.0114 and an HIR = 1.0.

Test O64B12: Building prototype B - climate zone 12 - Roseville

The chiller for this test is a variable speed drive (VSD) chiller modeled with an EIR = 0.2275.

Test O65B12: Building prototype B - climate zone 12 - Roseville

The chiller for this test is a screw chiller modeled with an EIR = 0.2275.

Test O66B12: Building prototype B - climate zone 12 - Fairfield

The chiller for this test is also a screw chiller modeled with an EIR = 0.2275 in a different city in climate zone 12.

5.3.7 O7 Test Series - Additional HVAC System Options

This series tests various additional HVAC system options. These tests use the ten (10) zone B building prototype with the same features used (except as noted) in test F13B12. All runs have a central HVAC system with the same chiller as that used in test F13B12 and (where needed) a gas-fired boiler for hot water reheat.

Test O71B12: Building prototype B - climate zone 12 - Sacramento

Individual hydronic heat pumps (< 75K Btuh) are modeled for each zone. The heat pumps all have EER = 11.0 and COP = 3.8.5.3.8 O8 Test Series - Optional Shading Devices.

This test series tests the effects of optional shading devices, in particular sidefins. In this series sidefins are tested in two hot climate zones at both ends of the state to maximize differences in latitude and thus solar angles. The building is the same as that used in Test C11A10 except as noted below.

The occupancies and lighting are the same as that specified for **Test OC2A09** and the **O3 Test Series**.

Test O81A11: Building prototype A - climate zone 11 - Red Bluff

The glazing is the same as in Test C11A10 except that there are 2 ~~foot~~ft deep sidefins every 5 ~~feet~~ft that are the same height as the windows.

Test O82A15: Building prototype A - climate zone 15 - Palm Springs

This test is the same as Test O81A11 except that the test is modeled in climate zone 15 - Palm Springs.

5.3.8 O9 Test Series - Evaporative Cooling Options

This test series tests direct, indirect, and direct/indirect evaporative cooling systems. Evaporative cooling is used both alone or as a precooling system. The building is the same as that used in Test C11A10 except as noted below. The occupancy type is the grocery with 12% storage space; and lighting (with lighting plans) is set at 1.65 watts per square foot for all spaces modeled.

Standard Design Assumptions. The standard HVAC system for evaporative cooling is a DOE 2.1E gas/electric packaged single zone unit [DOE 2.1E PSZ] with a fan power index 0.196 watts per cfm less than the proposed system which has additional fan capacity to move high air volumes required for evaporative cooling. The DOE 2.1E reference program characteristics for the standard system include [SUPPLY-DELTA-T = 1.815] and [SUPPLY-KW = 0.000587].

Proposed Design Assumptions. The proposed HVAC system for these O9 series tests will include the evaporative cooling system plus a backup DOE 2.1E packaged single zone [PSZ] with [SUPPLY-DELTA-T = 2.42] to account for additional heating of the air stream by additional and/or larger fans, [SUPPLY-KW = 0.000783] to account for the evaporative cooling fan. **ACMs may allow user entry of supplementary fan and pump power but they ~~must~~shall have a minimum supplementary power use (similar to the fan power index) of 0.5 watts per cfm to account for supplementary fans and pumps [EVAP-CL-KW not less than 0.0005 (DOE 2.1 Default)].** The entry for [EVAP-CL-KW] for DOE 2.1E is given:

Equation N5-1

$$[\text{EVAP} - \text{CL} - \text{KW}] = 0.746 \times \frac{(\text{EF}_{sp} + \text{EP}_{sp})}{0.85}$$

where

EF_{sp} is the nameplate horsepower of the evaporative supplementary fan(s)

EP_{sp} is the nameplate horsepower of the evaporative supplementary pump(s)

0.85 is a power factor to convert nameplate horsepower to brakehorsepower

For the proposed design, an ACM ~~must~~shall limit direct and indirect evaporative cooling effectiveness to the DOE 2.1E defaults as a maximum entry.

Test O91A13: Building prototype A - climate zone 13 - Fresno

A packaged single zone system is modeled with supplemental indirect evaporative cooling. This test is used to verify the proper upsizing of an undersized cooling system, as well as to ensure that the evaporative cooling is not upsized. This test is also used to verify the correct accounting of supplemental energy associated with the evaporative cooling process, and the implementation of the indirect cooling algorithms.

Test O92A11: Building prototype A - climate zone 11 - Redding

A standalone indirect/direct evaporative cooler is modeled with no supplemental air conditioning proposed. This test is used to verify the correct selection of the standard HVAC system and the ability of the ACM to create the proper cooling system which functions with the evaporative cooling system as a supplement to mechanical cooling. This test is also used to verify the correct implementation of the indirect/direct evaporative cooling algorithms.

Test O93A12: Building prototype A - climate zone 12 - Roseville

A standalone indirect/direct evaporative cooler is modeled with no supplemental air conditioning proposed. This test is the same as Test 092A11 except modeled in a different city with a milder cooling climate where the evaporative cooler alone may be sufficient. This test is used to verify the correct selection of the standard HVAC system and the ability of the ACM to determine the need for the proper cooling system which functions with the evaporative cooling system as a supplement to mechanical cooling and create it if needed.

Test O94A13: Building prototype A - climate zone 13 - Fresno

A standalone indirect/direct evaporative cooler is modeled with no supplemental air conditioning proposed. This test is the same as Test 092A11 except modeled in a different city with a milder cooling climate where the evaporative cooler alone may be sufficient. This test is used to verify the correct selection of the standard HVAC system and the ability of the ACM to determine the need for the proper cooling system which functions with the evaporative cooling system as a supplement to mechanical cooling and create it if needed.